AMENDMENTS TO THE CLAIMS

1-69 (Canceled)

70. (New) An optical signal processing method for optically analog-to-digital-converting an optical analog signal into an optical digital signal, the method including the steps of:

optically sampling the optical analog signal using a sampled signal having a predetermined sampling frequency, and outputting control light having a pulse train of optically sampled optical analog signal;

generating a pulse train of signal light which is synchronized with the sampled signal and has a first wavelength; and

optically encoding the pulse train of the signal light according to the control light having the pulse train of the optically sampled optical analog signal, by using a plurality of optical encoders each including nonlinear optical loop mirrors having input-to-output characteristics with different periodicities with respect to light intensity, and outputting a plurality of pulse trains of optically encoded signal light from said optical encoders, respectively; and

performing optical threshold processing on the plurality of pulse trains of optically-encoded signal light to optically quantize the plurality of pulse trains of optically-encoded signal light, by using at least one of optical threshold processors each of which is connected to each of said optical encoders and includes a nonlinear optical device having a nonlinear input-to-output characteristic with respect to light intensity, and outputting optically quantized pulse trains as optical digital signals.

71. (New) The optical signal processing method as claimed in claim 70,

wherein said plurality of optical encoders are "N" optical encoders each having an input-to-output characteristic with a period of $T\times2^{(N-2)}$, where "N" is a natural number (N = 1, 2, 3...) indicating a quantifying bit number.

72. (New) The optical signal processing method as claimed in claim 70,

wherein said nonlinear optical loop mirror is set to satisfy a relationship of $G<2Tth+1$, where "G" is a ratio of amplification of the signal light propagating in the same direction as that of the control light, where the amplification is caused by a parametric gain in a nonlinear medium of said nonlinear optical loop mirrors, and "Tth" is a ratio of amplification to the maximum value of power of the outputted signal light.

73. (New) An optical signal processing device for optically analog-to-digital-converting an optical analog signal into an optical digital signal, said device comprising:

an optically sampling device for optically sampling the optical analog signal using a sampled signal having a predetermined sampling frequency, and outputting control light having a pulse train of optically sampled optical analog signal;

a signal generating device for generating a pulse train of signal light which is synchronized with the sampled signal and has a first wavelength; and

an optically encoding device for optically encoding the pulse train of the signal light according to the control light having the pulse train of the optically sampled optical analog signal, by using a plurality of optical encoders each including nonlinear optical loop mirrors having input-to-output characteristics with different periodicities with respect to light intensity, and outputting a plurality of pulse trains of optically encoded signal light from said optical encoders, respectively; and

an optically quantizing device for performing optical threshold processing on the plurality of pulse trains of optically-encoded signal light to optically quantize the plurality of pulse trains of optically-encoded signal light, by using at least one of optical threshold processors each of which is connected to each of said optical encoders and includes a nonlinear optical device having a nonlinear input-to-output characteristic with respect to light intensity, and outputting optically quantized pulse trains as optical digital signals.

74. (New) The optical signal processing device as claimed in claim 73,

wherein said plurality of optical encoders are "N" optical encoders each having an input-to-output characteristic with a period of $T\times2^{(N-2)}$, where "N" is a natural number (N = 1, 2, 3...) indicating a quantifying bit number.

75. (New) The optical signal processing device as claimed in claim 73,

wherein said nonlinear optical loop mirror is set to satisfy a relationship of $G<2Tth+1$, where "G" is a ratio of amplification of the signal light propagating in the same direction as that of the control light, where the amplification is caused by a parametric gain in a nonlinear medium of said nonlinear optical loop mirrors, and "Tth" is a ratio of amplification to the maximum value of power of the outputted signal light.

76. (New) A nonlinear optical loop mirror comprising an optical fiber, a photo-coupler, a control-light input device for inputting a control light signal to said optical fiber, and a nonlinear medium placed on an optical path of said optical fiber,

wherein said photo-coupler is connected so as to branch an input optical signal inputted from an optical-signal input end into two optical signals and to output the optical signals to both ends of said optical fiber and connected so as to branch and output optical signals outputted from the both ends of said optical fiber to said optical-signal input end and an optical-signal output end, respectively,

wherein said nonlinear optical loop mirror adjusts a phase difference between optical signals inputted to the both ends of said optical fibers according to power of the control light signal so as to control power of the output optical signal outputted from said optical-signal output end, and

wherein said nonlinear optical loop mirror suppresses a parametric gain caused among the respective branched optical signals and the control light signal, so that a ratio of the power of the output optical signal to the maximum value thereof becomes equal to or smaller than a predetermined threshold value when a difference between phase shifts caused to the respective branched optical signals is set to $2n\pi$ (where "n" is an integer equal to or larger than 1), where the phase shifts are caused by cross-phase modulation (XPM) generated among the respective branched optical signals and the control light signal.

77. (New) The nonlinear optical loop mirror as claimed in claim 76,

wherein a relationship of G<2Tth+1 is set to be satisfied, where "G" is a ratio of amplification of the optical signal propagating in the same direction as that of the control light signal, where the amplification is caused by the parametric gain, and "Tth" is a ratio of the predetermined threshold value to the maximum value of the output optical signal.

78. (New) The nonlinear optical loop mirror as claimed in claim 76,

wherein one of the input optical signal and the control light signal is inputted after passing through an optical delay line, so that pulses of the optical signals and pulses of the control light signal are superimposed on each other over a predetermined range of said nonlinear medium.

79. (New) The nonlinear optical loop mirror as claimed in claim 76,

wherein polarization states of the optical signals and the control light signal are substantially identical to each other in said optical fiber and said nonlinear medium.

80. (New) The nonlinear optical loop mirror as claimed in claim 77,

wherein the predetermined threshold value is a threshold value required for quantization and encoding processings for optical analog-to-digital conversion.

81. (New) The nonlinear optical loop mirror as claimed in claim 77,

wherein the predetermined threshold value is 3 dB.

82. (New) The nonlinear optical loop mirror as claimed in claim 76,

wherein one of the following conditions is set to be satisfied:

(a) a dispersion value of said nonlinear medium is equal to or smaller than the minimum dispersion value of dispersion values when the parametric gain caused among the optical signals and the control light signal is equal to or larger than a predetermined value; and

(b) a dispersion value of said nonlinear medium is equal to or larger than the maximum dispersion value of dispersion values when the parametric gain caused among

the optical signals and the control light signal is equal to or larger than a predetermined value.

83. (New) The nonlinear optical loop mirror as claimed in claim 76,

wherein a wavelength difference between the control light signal and the input optical signal is larger than the maximum wavelength difference which cause a parametric gain equal to or larger than a predetermined value among the optical signals and the control light signal.

84. (New) The nonlinear optical loop mirror as claimed in claim 77,

wherein an absolute value of a product of a wavelength difference between the control light signal and the optical signals, and a dispersion value of said nonlinear medium is equal to or smaller than a value which suppress walk-off and set a phase shift difference between the branched optical signals due to cross-phase modulation (XPM) caused among the respective optical signals and the control light signal to be equal to or larger than 2π.

85. (New) A nonlinear optical loop mirror comprising an optical fiber, a photo-coupler, a control-light input device for inputting a control light signal to said optical fiber, and a nonlinear medium placed on an optical path of said optical fiber,

wherein said photo-coupler is connected so as to branch an input optical signal inputted from an optical-signal input end into two optical signals and to output the optical signals to both ends of said optical fiber and connected so as to branch and output optical signals outputted from the both ends of said optical fiber to said optical-signal input end and an optical-signal output end,

wherein said nonlinear optical loop mirror adjusts a phase difference between optical signals inputted to the both ends of said optical fibers according to power of the control light signal so as to control power of the output optical signal outputted from said optical-signal output end,

wherein a dispersion characteristic of said nonlinear medium has a normal dispersion characteristic, at a wavelength of the control light signal, and

wherein one of the following conditions is set to be satisfied:

(a) a dispersion value of said nonlinear medium at a wavelength of the control light signal is equal to or smaller than -0.62 ps/nm/km and a wavelength difference between the input signal light and the control light is equal to or larger than 16 nm; and

(b) a dispersion value of said nonlinear medium at a wavelength of the control light signal is equal to or smaller than -0.315 ps/nm/km and a wavelength difference between the input signal light and the control light is equal to or larger than 20 nm.

86. (New) The nonlinear optical loop mirror as claimed in claim 85,

wherein polarization states of the optical signals and the control light signal are substantially identical to each other in said optical fiber and said nonlinear medium.

87. (New) A nonlinear optical loop mirror comprising an optical fiber, a photo-coupler, a control-light input device for inputting a control light signal to said optical fiber, and a nonlinear medium placed on an optical path of said optical fiber,

wherein said photo-coupler is connected so as to branch an input optical signal inputted from an optical-signal input end into two optical signals and to output the optical signals to both ends of said optical fiber and connected so as to branch and output optical signals outputted from the both ends of said optical fiber to said optical-signal input end and an optical-signal output end,

wherein said nonlinear optical loop mirror adjusts a phase difference between optical signals inputted to the both ends of said optical fibers according to power of the control light signal so as to control power of the output optical signal outputted from said optical-signal output end,

wherein a difference between phase shifts caused to the respective optical signals, due to cross-phase modulation (XPM) caused between the respective optical signals and the control light signal, is equal to or larger than 2π,

wherein said nonlinear medium has a normal dispersion characteristic, at a wavelength of the control light signal, and

wherein said nonlinear optical loop mirror suppresses a parametric gain caused among the respective branched optical signals and the control light signal, so that a ratio

of the power of the output optical signal to the maximum value thereof becomes equal to or smaller than a threshold value for optical analog-to-digital conversion when a difference between phase shifts caused to the respective branched optical signals is set to $2n\pi$ (where "n" is an integer equal to or larger than 1), where the phase shifts are caused by cross-phase modulation (XPM) generated among the respective branched optical signals and the control light signal.

88. (New) The nonlinear optical loop mirror as claimed in claim 87,

wherein polarization states of the optical signals and the control light signal are substantially identical to each other in said optical fiber and said nonlinear medium.

89. (New) A method for designing a nonlinear optical loop mirror comprising an optical fiber, a photo-coupler, a control-light input device for inputting a control light signal to said optical fiber, and a nonlinear medium placed on an optical path of said optical fiber,

wherein said photo-coupler is connected so as to branch an input optical signal inputted from an optical-signal input end into two optical signals and to output the optical signals to both ends of said optical fiber and connected so as to branch and output optical signals outputted from the both ends of said optical fiber to said optical-signal input end and an optical-signal output end,

wherein said nonlinear optical loop mirror adjusts a phase difference between optical signals inputted to the both ends of said optical fibers according to power of the control light signal so as to control power of the output optical signal outputted from said optical-signal output end, and

wherein the method including the steps of:

a first step of determining a transfer function and a period (ϕ_{max}) of the transfer function, the transfer function being expressed as a relationship of power of an input optical signal with respect to power of an output optical signal;

a second step of determining a threshold value of the output optical signal suitable for optical signal processing;

a third step of provisionally determining a nonlinearity constant and a dispersion characteristic of said nonlinear medium, and a wavelength and a peak power of the control light signal;

a fourth step of judging whether or not a phase shift reaches the period ϕ_{max}, and proceeding to a fifth step when the phase shift reaches the period ϕ_{max}, while returning to the third step when the phase shift does not reach the period ϕ_{max}; and

the fifth step of judging whether or not a relationship of $G<2Tth+1$ is satisfied, where "G" is a ratio of amplification of the optical signal propagating in the same direction as that of the control light signal, where the amplification is caused by the parametric gain, and "Tth" is a ratio of the predetermined threshold value to the maximum value of the output optical signal, and setting the nonlinearity coefficient and the dispersion characteristic of the nonlinear medium and the wavelength and the peak power of the control light signal which have been provisionally determined to a designing determined value when the relationship is satisfied, while returning to the third step when the relationship is not satisfied.

90. (New) An optical signal conversion method including the steps of branching an input optical signal into two optical signals (A) and (B), propagating the optical signal (A) in the same direction as that of a control light signal having a different wavelength so as to cause cross-phase modulation, and changing a phase shift difference between the optical signals (A) and (B) periodically with respect to change in power of the control light signal so as to change power of output optical signal resulted from interference between the optical signals (A) and (B),

wherein the method includes the steps of suppressing a parametric gain caused between the optical signal (A) and the control light signal, so that the power of the output optical signal when the phase shift difference is $2n\pi$ (where "n" is an integer equal to or larger than 1) is equal to or smaller than a threshold value for quantization and encoding processings for optical analog-to-digital conversion, with respect to the maximum value of the power of the output optical signal.